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(71) Applicants:
- KUBOTA IRON WORKS CO., LTD.
Hiroshima-shi, Hiroshima-ken (JP)
- FUJI JUKOGYO KABUSHIKI KAISHA
Tokyo (JP)

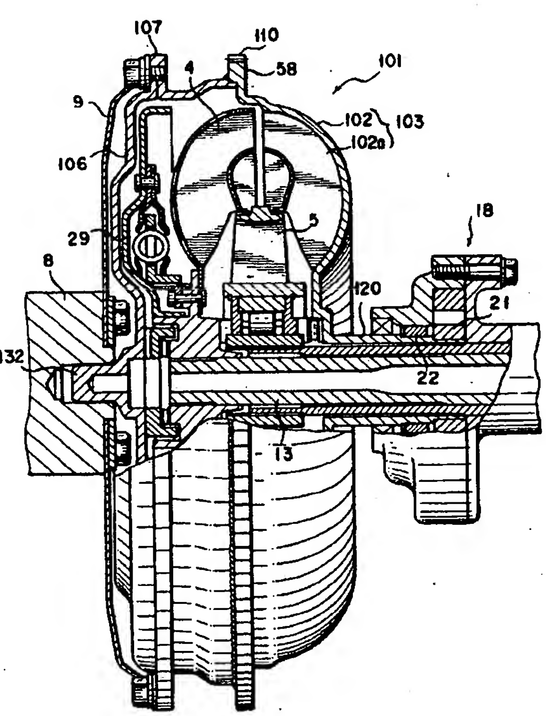
(72) Inventors:
- Yamanaka, Shigeaki
Aki-ku, Hiroshima-shi, Hiroshima (JP)
- Kobayashi, Toshio
Shinjuku-ku, Tokyo (JP)

(74) Representative:
Schmitt, Armand et al
Office Ernest T. Freylinger S.A.,
B.P. 48
8001 Strassen (LU)

(54) Torque converter

(57) A torque converter comprises an impeller shell, a pump impeller integrally formed with the impeller shell, a turbine runner, a stator, a front cover, and at least one of a flanged portion through which a driving power of an engine is transmitted and a ring gear for a starter. The flange portion is formed to an outer peripheral portion of an outer hull constituting member including the impeller shell and the front cover. A pilot boss portion disposed to an axial portion of the front cover and adapted to be fitted to a crank shaft of the engine, and an oil pump driving shaft in shape of sleeve disposed to an axial portion of the impeller shell and adapted to drive an oil pump. The pilot boss portion is formed integrally with the front cover through a plastic working and the flanged portion is formed to a front portion of the outer periphery of the front cover is increased in thickness through a plastic working as a laminated thickness increased portion.

FIG. 8



EP 0 997 666 A2

Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a torque converter used for an automatic transmission mechanism of a vehicle and, more particularly, relates to components constituting an outer hull (structure, casing) of a torque converter.

[0002] The torque converter of an automobile is equipped with a lock-up clutch which functions to improve fuel consumption of an engine while giving two operation modes, i.e. one operation mode (torque converter state) and the other operation mode (lock-up state). In the first operation mode (torque converter state), an output element is rotated with increasing torque by a reaction force of a stator while circulating a hydraulic oil to an impeller of the output element (generally, turbine runner) and a reaction element (generally, stator) by the rotation of an impeller of an input element (generally, pump impeller) driven by the engine. And in the second operation mode (lock-up state), the engine turns the output element by coupling the input and output element by fixing the lock-up clutch.

[0003] The Japanese Patent Laid-open Publication No. HEI 7-33861 of the same applicant discloses conventional examples of a front cover and a pump impeller which are constructional elements of a torque converter equipped with a lock-up mechanism of the type mentioned above.

[0004] In such conventional examples, a rotating power from the engine is transmitted to a flange portion, which performs as an inertia function. And a starter gear is meshed with an annular ring gear. The flange and the gear are formed on an outer peripheral surface of the torque converter. The ring gear is meshed with a pinion of a starter motor at a starting time of the engine operation for transmitting the rotating force of the starter motor to a crank shaft of the engine.

[0005] Fig. 1 shows a structure of the torque converter provided with the conventional lock-up mechanism mentioned above.

[0006] With reference to Fig. 1, the torque converter 1 is composed of a pump impeller 3 formed by integrally coupling an impeller 2a to an impeller shell 2, a turbine runner 4 and a stator 5. The impeller shell 2 of the pump impeller 3 is integrally coupled to a front cover 6 by welding. The front cover 6 is formed on an outer peripheral surface with an annular flange portion 7. And a drive plate 9 coupled to a engine crank shaft 8 is fastened by means of bolt. A ring gear 10 for the stator 5 is provided at an outer peripheral surface of the impeller shell 2.

[0007] The detailed structure of the conventional torque converter will be further explained hereunder with reference to Fig. 1.

[0008] The turbine runner 4 is mounted to a turbine hub 12 by rivets, for example, and an input shaft 13 is connected to the turbine hub 12 in a spline coupling engagement. The stator 5 is supported by a hollow fixed shaft 17 through an outer race 14. A sprag 15 and an inner race 16 constitute a one-way clutch to be rotatable in one direction. The hollow fixed shaft 17 is fastened to a housing 19 of an oil pump 18 by bolts and is coupled to the inner race 16 in a spline engagement.

[0009] An oil pump driving shaft 20 in shape of sleeve is provided at a shaft core portion of the impeller shell 2 of the pump impeller 3, and an inner rotor 21 of the oil pump 18 is coupled to the oil pump driving shaft 20 so as to be driven rotatably.

[0010] One example of such coupling structure of the inner rotor 21 to the oil pump driving shaft 20 of the impeller shell 2 is disclosed in the Japanese Utility Model Laid-open Publication No. HEI 5-34348). That is, a width across flat portion is formed on an outer periphery of a front (tip) end portion of the oil pump driving shaft 20, and another width across flat portion is formed to an inner surface of the inner rotor 21 of the oil pump 18, when both widths across flat portions are engaged, the oil pump driving shaft 20 and the inner rotor 21 of the oil pump 18 are coupled to be driven in the rotational direction.

[0011] Further, an outer periphery of a cylindrical portion at an approximately axial central portion of the oil pump driving shaft 20 is rotatably supported by an inner peripheral surface of a bush 22 fixed to the housing 19 of the oil pump 18 so as to bear the driving load of the oil pump 18 at this portion. Accordingly, a driving load in proportion to a discharge pressure (line pressure) of the oil pump 18 is applied to the width across flat portion of the oil pump driving shaft 20 and the portion thereof supported by the bush 22.

[0012] Stator collars 23a and 23b are mounted on both sides of the sprag 15 of the one-way clutch, and thrust bearings 24a and 24b are interposed between a pilot boss portion 32 as described hereinafter and the turbine hub 12 and between the stator collar 23b and the oil pump driving shaft 20, respectively.

[0013] The pump impeller 3 driven by the rotation of the crank shaft 8 (of the engine) acts to circulate the hydraulic oil filling in a torque converter chamber 25, and the hydraulic oil circulates in passages of the respective impellers of the pump impeller 3, the turbine runner 4 and the stator 5, whereby the turbine runner 4 is rotated while increasing the torque by the reaction force due to the operation of the stator 5, and the rotating force is transmitted to the input shaft 13 through the turbine hub 12 and then to an automatic transmission mechanism or non-stage transmission mechanism, not shown.

[0014] A lock-up clutch hub 27 of a lock-up clutch 26 is fastened to the turbine hub 12 by rivets, and the lock-up clutch hub 27 is provided with a torsional damper 28 for damping a shock at a time of clutch engagement and for absorbing vibrations or noises of the driving system.

[0015] The lock-up clutch 26 is provided with a lock-up piston 29 at a portion between the lock-up clutch hub 27 and the front cover 6. And the lock-up piston 29 is fitted to the turbine hub 12 in a fashion that the inner peripheral portion of the lock-up piston 29 is slidable in an axial direction of the turbine hub 12 in a liquid tight manner with respect to the outer peripheral portion of the turbine hub 12. The inside inner peripheral portion of the torsional damper 28 is spline-engaged with the outer peripheral portion of the lock-up clutch hub 27. Further, the lock-up piston 29 is provided with a lock-up facing 30 on a side surface portion on the side of the front cover 6.

[0016] A front hydraulic chamber 31 is defined between the lock-up piston 29 and the front cover 6. The engine crank shaft 8 is formed with a center hole to which a pilot boss portion 32 provided to the front cover 6 is fitted so as to achieve a rotational axis alignment of the torque converter 1. The front hydraulic chamber 31 is communicated with an oil passage 33 formed within the input shaft 13 and then communicated with a control valve of a hydraulic controller of the automatic transmission mechanism or non-stage transmission mechanism, not shown.

[0017] The torque converter 1 has an oil passage between the hollow fixed shaft 17 and the oil pump driving shaft 20. The passage is communicated to a groove formed on the side surface of the thrust bearing 24b disposed between the stator collar 23b and the oil pump driving shaft 20, the passage then being communicated with the hydraulic controller.

[0018] At the lock-up time, a hydraulic pressure is applied to the turbine-side side surface of the lock-up piston 29 from the inside of the torque converter 1 through the oil passage between the stator collar 23b and the oil pump driving shaft 20, and at the same time, the pressurized oil in the front hydraulic chamber 31 is drained thereby to cause a pressure difference between the front and rear portions of the lock-up piston 29 (so as to make the hydraulic pressure in the front hydraulic chamber 31 smaller than that in the torque converter). Thus, the lock-up piston 29 is pushed to the front cover 6 via the lock-up facing 30 to accomplish the lock-up state.

[0019] Further, when the lock-up state is released if required, the pressurized oil is supplied into the front hydraulic chamber 31. And the hydraulic pressure in the oil passage from the inside of the torque converter 1 is controlled by the control valve of the hydraulic controller to cause the pressure difference between the front hydraulic chamber and the torque converter (so as to make the hydraulic pressure in the front hydraulic chamber 31 larger than that in the torque converter), whereby the lock-up state is released.

[0020] In the torque converter 1 of the structure mentioned above, the outer hull has the front cover 6, the impeller shell 2. And as the outer hull is generally formed by a thin steel plate projections (protrusions), thickened portions and thinned portions may be formed partially as required.

[0021] The thickness may be changed if a certain strength or rigidity is required. And the outer hull portion of the torque converter 1 has a thickened flanged portion 7 for receiving an inertia. And the outer hull has the drive plate tightened by bolts, or there is provided a pilot boss portion 32 adapted to make align with the crank shaft 8 to the front cover 6. These members are independently manufactured and integrally assembled together by means of welding, for example, as shown in Fig. 2.

[0022] The impeller shell 2 will be manufactured such as shown in Fig. 3. That is, the ring gear 10, the sleeve-shaped oil pump driving shaft 20 and so on, which are independently manufactured, are coupled to the outer peripheral portion of the impeller shell 2 formed of a thin iron plate and the inner peripheral portion thereof, respectively, by welding, for example.

[0023] A centrifugal force is generated in accordance with the increase of the engine revolution, an axial thrust force is generated due to the circulation of the hydraulic fluid through the pump impeller 3, the turbine runner 4 and the stator 5, in this order, and a working force of the lock-up clutch 26 is also generated. These forces are applied to the outer structural members or portions constituting the outer hull of the torque converter 1. For this reason, it is necessary for the outer structural members such as impeller shell 2 and the front cover 6 to operate with withstanding against such forces and suppressing the deformation such as axial swelling thereof in an allowable predetermined value. In this regard, for example, it is preferred that the front cover 6 is formed of an iron plate having a relatively large thickness of about 4.5 to 6 mm and the impeller shell 2 is formed of an iron plate having a thickness of about 3 to 4 mm.

[0024] In the prior art mentioned hereinbefore, the sleeve-shaped (cylindrical) oil pump driving shaft 20 integrally coupled to the impeller shell 2 is formed at its rear end portion with width across flat portion which is fitted to the width across flat portion formed to the inner peripheral portion of the inner rotor 21 of the oil pump 18 thereby to rotate the pump, and furthermore, the cylindrical portions, other than the width across flat portions are also fitted with high accuracy so as to achieve the rotational alignment between the oil pump driving shaft 20 and the oil pump rotor (including inner rotor 21 and outer rotor).

[0025] Furthermore, a hydraulic pressure of the automatic transmission mechanism (i.e. pump discharge pressure or line pressure) generated by the inner rotor 21 of the oil pump 18 is applied to a projected area of the outer periphery of the oil pump rotor, so that a load corresponding to the projected area acts on the fitting portion of the central cylindri-

cal portion of the oil pump shaft 20 and the inner rotor 21. The load acting on this filling portion constitutes a moment load corresponding to a distance from the bush 22 supporting the central portion of the oil pump driving shaft 20 to the filling portion of the inner rotor 21, and the moment load hence acts on the bush 22. The bush 22 axially supports the entire structure of the torque converter, so that, other than the above load, an eccentric load or swing load due to the misalignment at the mounting time of the torque converter assembly to the drive plate 9 can be supported.

[0026] The structure of the outer hull of the torque converter mentioned above and the manufacturing process thereof has provided the following problems.

[0027] That is, the front cover and the impeller shell comprising a plurality of parts which are respectively independently manufactured, and the parts are thereafter assembled integrally by means of welding, for example, so that many processes are required, involving much cost as well as bad production efficiency. Furthermore, since, in general, the body of the front cover is manufactured through a press working, a soft steel plate is generally used because of its well formability (yieldability). However, it is necessary to increase the thickness of the soft steel plate in order to ensure the strength and rigidity thereof, in the case of using for high revolution and high torque engines, because the front cover body bears the centrifugal hydraulic pressure generated in the highly rotating torque converter and is subjected to the thrust load from the turbine runner and the pressing load of the lock-up clutch. Accordingly, in spite of the fact that it is important to achieve the light-weight requirement and vibration reducing requirement while ensuring the inertia moment required for a rotating member, it is difficult to prevent the structure from increasing of the weight, thus the problems remaining unsolved.

[0028] Still furthermore, it is required for the torque converter of the automatic transmission mechanism or non-stage transmission mechanism to accord (cooperate) with a lean combustion type engine or direct-injection type engine in place of a conventional engine in the viewpoints of environmental pollution and improvement of fuel consumption. However, in the torque converter having the outer hull of the conventional structure, the above viewpoints have been easily handled by making thin the thickness of a member constituting the outer hull or mounting an inertial ring to a vacant space. Therefore, it is very difficult for the member constituting the outer hull of the torque converter to have the effective inertia moment against the strong accelerating force from stopping state of the automobile and the lightening of the engine due to the problem of vibration of the engine. Accordingly, the weight of the engine has been further increased, constituting the further problems hindering a realization the lightening of weight or compact structure of the engine.

[0029] Further, the oil pump driving shaft, having a thin sleeve shape, which is welded to the pump impeller, is hardened to provide substantially hardness of HRC18 by heat treatment because a transverse load due to the pump discharge pressure is applied to the fitting portion to the oil pump rotor and a load due to the pump driving torque is applied to the pump rotor driving portion. However, in general, the pump discharge pressure in an automatic transmission mechanism is about 1.5 to 1.8 Mpa, and that in a metal-belt type non-stage transmission mechanism is about 4 to 5 Mpa, and accordingly, when used for the automatic transmission mechanism, the drive shaft and the supporting bush of the oil pump are easily broken by fatigue.

[0030] As a countermeasure to the above defects, there is considered a change to a material hardened by heat treatment such as high-frequency wave (induction) heating and/or increasing of the thickness of the oil pump driving shaft, or there is also considered an entire change of a support structure supporting the pump rotor. However, such countermeasures will make large the entire structure of the apparatus, increase the weight thereof and increase the manufacturing cost, which will hence constitute bars (barriers) for improving the production efficiency and the lightening of the apparatus, thus providing problems.

SUMMARY OF THE INVENTION

[0031] An object of the present invention is to substantially eliminate defects or drawbacks encountered in the prior art mentioned above and to provide a torque converter capable of reducing the manufacturing cost thereof, realizing a light weight requirement without damaging the strength and rigidity of members constituting the outer hull of the torque converter, effectively reducing or eliminating fatigue failure of an oil pump driving shaft and damage to a bush rotationally supporting the oil pump driving shaft.

[0032] Other objects can be achieved according to the present invention by providing a torque converter which comprises an impeller shell, a pump impeller integrally formed with the impeller shell, a turbine runner, a stator, a front cover, at least one of a flanged portion through which a driving power of an engine is transmitted and a ring gear for a starter formed to an outer peripheral portion of an outer hull constituting member including the impeller shell and the front cover, a pilot boss portion disposed to an axial portion of the front cover and adapted to be fined to a crank shaft of the engine, and an oil pump driving shaft in shape of sleeve disposed to an axial portion of the impeller shell and adapted to drive an oil pump, wherein the pilot boss portion is formed integrally with the front cover through a plastic working and the flanged portion is formed to a front portion of the outer periphery of the front cover is increased in thickness through a plastic working as a laminated thickness increased portion.

[0033] In a preferred embodiment, a liquid-tight brazing and a coating layer is formed to at least a portion, of an inner peripheral side boundary portion of the flanged portion, which is short-circuited to a screw hole portion formed to the flanged portion.

[0034] The sleeve-shaped oil pump driving shaft is formed integrally with the impeller shell through the plastic working and the ring gear for the starter is integrally formed so as to form an increased thickness portion through the plastic working.

[0035] The ring gear for the starter is integrally formed to a rear portion of the outer periphery of the front cover through a plastic working. The flanged portion and the ring gear for the starter are integrally formed through the plastic working to the outer peripheral portion of the outer hull composed of the front cover and the impeller shell so that the integrally formed portions perform an inertia function and a power transmission function.

[0036] At least either one of the front cover and impeller shell are formed, through a molding process, of a steel plate material consisting of, in weight %, C: 0.2-0.6, Si: 0.01-0.1, Mn: 0.05-0.5, Ti: 0.01-0.1, B: 0.001-0.01, and Fe: residue. An induction hardening is carried out to at least a portion, of the oil pump driving shaft, which is fined to the rotor of the oil pump and a bush fitting portion supported to a housing of an oil pump through the bush. An induction microwave hardening is also carried out to an inside surface of the oil pump driving shaft, which is opposed to a disc surface of the stator through a thrust bearing.

[0037] The induction micro-wave hardening is also carried out to at least one of an inner surface of a disc portion of the front cover, a surface thereof opposing to a turbine hub through a thrust bearing and a central protruded portion thereof.

[0038] According to the present invention of the characters and structures mentioned above, the front cover and the impeller shell constituting the outer hull of the torque converter are integrally formed, through the plastic working, with the associated members such as the pilot boss portion, the flanged portion, the ring gear and the oil pump driving shaft. Accordingly, in comparison with the conventional torque converter in which the associated members mentioned above are independently formed and then assembled with the front cover and the impeller shell which are also independently formed, the productivity of the front cover and the impeller shell of the torque converter according to the present invention provided with the associated members mentioned above can be improved and the manufacturing cost can be hence reduced. In addition, as the respective members are integrally formed, unnecessarily thickened portions are eliminated, thus realizing the light weight requirement of the entire structure of the torque converter.

[0039] Furthermore, welding works can be effectively eliminated to the ring gear for the starter and the flanged portion through which the engine driving power is transmitted. The elimination of such welding works can prevent the formation of irregularly thickened portion due to the welding and prevent the occurrence of defects which may be caused by the welding. Therefore, the adjustment of rotational balance after the assembling of the torque converter can be easily performed, and moreover, oil leakage due to the welding defect will be also prevented, whereby the quality of products and the productivity can be improved.

[0040] Still furthermore, according to the present invention, the front cover and the impeller shell are formed of a material including boron (B) in addition to carbon (C) of 0.5 weight %, so that the induction hardening can be effectively applied to the members as required, thereby improving the strength and rigidity of the fitting portion between the oil pump drive shaft and the oil pump rotor and the bush rotation support portion and the gear teeth of the ring gear to prevent the portions or members from being damaged, worn and deformed.

[0041] Still furthermore, the front cover and the impeller shell can be formed from a steel plate having a thickness thinner than that used for the conventional structure. Moreover, in a case where the engine is operated with a revolution number increased in a red zone under the lock-up condition, a compound force of the centrifugal hydraulic pressure acting on the torque converter and the lock-up clutch engaging load can be born and at least a permanent deformation can be prevented from causing, even if a thin steel plate be used, by performing, as required, the micro-wave induction hardening to or partially increasing the thickness of the outer peripheral bent portion at which large bending stress is caused.

[0042] Still furthermore, in spite of the use of the thin steel plate while maintaining the high strength and rigidity, the flanged portion formed to the outer periphery of the front cover is increased in thickness and the ring gear disposed to the outer periphery of the impeller shell is also increased in thickness by a roll spinning process, so that the inertial mass can be most effectively ensured to the outer peripheral portion of the torque converter without arranging an inertia ring as additional member as that in the conventional structure, thus realizing the light weight requirement. In particular, even in a case where it is required to improve an environmental pollution and fuel consumption in the use of a lean combustion engine or direct-injection combustion engine, the inertia can be ensured and the light weight can be realized while maintaining the improved productivity and reduced manufacturing cost.

[0043] The nature and further characteristic features of the present invention will be made further clear from the following descriptions made with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0044] In the accompanying drawings:

Fig. 1 is a partial sectional view of a main portion of a torque converter of a conventional structure;
Fig. 2 is a sectional view showing a front cover of the torque converter of Fig. 1 for the explanation of a manufacturing process thereof;
Fig. 3 is a sectional view showing an impeller shell of the torque converter of Fig. 1 for the explanation of a manufacturing process thereof;
Figs. 4A to 4H are sectional views showing a manufacturing process in the illustrated order;
Fig. 5 is a sectional view of the front cover of the torque converter of the present invention;
Fig. 6 is a sectional view corresponding to Fig. 4C showing another example of a front cover;
Figs. 7A to 7F are sectional views showing a manufacturing process of an impeller shell;
Fig. 8 is a partial sectional view of an essential portion of the torque converter according to the present invention;
Figs. 9A and 9B are front views showing patterns formed to the front cover by micro-wave induction hardening; and
Fig. 10 shows a sectional view of a front cover of the torque converter according to another embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0045] A torque converter according to the present invention is entirely shown in Fig. 8, which is provided with improved impeller shell 102 and front cover 106 in comparison with those shown in Fig. 1, and preferred embodiments thereof will be described hereunder with reference to Figs. 4 to 10, in which reference numerals are applied to members or portions corresponding to those shown in Figs. 1 to 3.

[0046] Figs. 4A to 4H are views explaining plastic working steps of the front cover 106 in this order.

[0047] Fig. 4A shows a punch-out step for punching out a disc-shaped material 41 in a predetermined size, Fig. 4B shows a step for forming a swelled or protruded portion 42 at a central portion of the material 41 through a press working, and Fig. 4C shows a step for plastically forming a boss portion 45 constituting a pilot boss portion 132 of the front cover 106 by placing the swelled portion 42 on a mold 43 composed of a pin 43a and a die 43b and then press-forming the swelled portion 42 from the upper side thereof by using a formed roller 44. In these steps, the material volume of the swelled portion 42 is made larger than that of the boss portion 45, and accordingly, the thickness of the boss portion 45 is made larger than a plate thickness of the material 41. That is, the thickness of the boss portion 45 is increased.

[0048] In the next step shown in Fig. 4D, a cylindrical portion 46 is formed to the outer peripheral portion of the material 41 through a press working and a protrusion or projection 48 is formed, so as to project outward in an annular shape from an inside portion by a roller 47, to a portion constituting a flanged portion 107.

[0049] In a step shown in Fig. 4E, the cylindrical portion 46 is pressed in an axial direction thereof, and according to this pressing, buckling is formed to the protrusion 48 so as to provide a substantially Ω-shape in section. In a step shown in Fig. 4F, the outer shape of the protrusion 48 is shaped by a roller 49 and the protrusion 48 is then pressed and folded by upper and lower rollers 50a, 50b so as to form the flanged portion 107 having a semi-circular front end shape in a step shown in Fig, 4G. Thereafter, in a step shown in Fig. 4H, the front end is shaped by a roller 51 so as to provide a flat end shape, i.e. cylindrical shape of the flanged portion 107. Further, in the steps shown in Figs. 4F to 4H, a back-up die 52 is disposed to an inside portion of the cylindrical portion 46.

[0050] With reference to Fig. 5, the material 41 is thereafter entirely press-worked to provide the front cover shape and a screw hole 107a is formed to the flanged portion 107 through a drilling work. In this step, if the bolt screw hole 107a is communicated with an abutment portion 53 formed by folding the protrusion 48 in the step shown in Fig. 4G, an oil leakage may be caused. In order to obviate such defect, a brazing or coating treatment will be applied thereby to form a coating layer, thus performing a fluid-tight sealing to that portion.

[0051] Fig. 6 shows another example for forming the pilot boss portion 132 from the swelled portion 42 formed to the material 41 of the front cover 106, and in this example, the swelled portion 42 is formed so as to provide a shape aligning the shape of a mold 43 by means of a roller 44a having a small diameter.

[0052] Figs. 7A to 7F represent steps for the plastic working for forming the impeller shell 102.

[0053] In a step shown in Fig. 7A, a disc-shaped material 55 is punched out in a predetermined size, in a step shown in Fig. 7B, the material 55 is shaped so as to provide a semi-spherical shape through a press working, and in a step shown in Fig. 7C, a swelled or protruded portion 56 is formed to the central portion of the disc-shaped material 55 through a press working. In a step shown in Fig. 7D, the swelled portion 56 is subjected to a further press work so as to provide a sleeve-shaped shaft portion and an upper end (front end) of this sleeve-shaped shaft portion is cut away thereby plastically forming an oil pump driving shaft 120.

[0054] Thereafter, in a step shown in Fig. 7E, the material 55 is entirely press-worked so as to form an impeller shell

102 having a flanged portion 57 at the outer peripheral edge. In a step shown in Fig. 7F, the flanged portion 57 is increased in thickness, by a roil spinning method, so as to form a thickened portion 58. A ring gear 110 for a starter is worked through a rolling method or machining work.

[0055] Fig. 8 shows the torque converter 101 provided with the impeller shell 102 and the front cover 106 having the structures mentioned above formed in accordance with the steps also mentioned above. The impeller shell 102 is integrally coupled to an impeller 102a to form a pump impeller 103.

[0056] Hereunder, there will be described means for achieving purposes of lightening the weight of the torque converter and improving the strength and rigidity of the members constituting the same while ensuring the inertial mass.

[0057] A conventional front cover 6 and impeller shell 2 such as shown in Fig. 1 are formed of a material of SPC or SPHC and have plate thicknesses of 4.9 mm and 3.2 mm, respectively. On the other hand, according to the preferred embodiment of the present invention, the SPC material is changed to a material which is made by adding a small amount of boron (B) to an alloy material having a steel plate base containing a carbon (C) of 0.25 weight % and to which the induction hardening process is effectively performed. The SPC material has the best press formability, and although a material containing C of 0.5 weight % with B added can provide a high strength, it will provide less press formability. However, by reducing the plate thicknesses of the front cover 106 and the impeller shell 102, a working stress of a conventional extent can be maintained, so that the above change of the material does not apply an adverse effect for the production of the torque converter.

[0058] Furthermore, as the flanged portion 107 and the ring gear 110, are formed with the increased thicknesses, the purpose of the lightening of the weight can be realized while ensuring the necessary inertial mass because the portion 107 and the gear 110 are formed on the outer peripheral portions of the torque converter to be most effective for increasing the inertial mass.

[0059] In consideration of the above matters, as the materials 41 and 55 for the front cover 106 and the impeller shell 102, materials of S25CTiB containing titanium (Ti) and B and having thicknesses of 4.5 to 4.2 mm and 3.0 to 2.8 mm are utilized, respectively, in place of steel plate materials (SPC1) having thicknesses of 4.9 mm and 3.2 mm (JIS standard). The respective components of these S25CTiB and SPC1 materials are shown in the following Table 1. Wt.% means weight %.

Table 1

Kind of steel	C	Si	Mn	P	S	Ti	B	Plate Thickness
S25CtiB	0.25 (wt. %)	0.06	0.39	0.01	0.008	0.06	0.004	3.2 (mm)
SPC1	≤ 0.12 (wt. %)	≤ 1.2	≤ 0.5	≤ 0.04	≤ 0.045	-	-	4.9 (mm)

[0060] Further, although the respective components, other than phosphorus (P) and sulfur (S), of the steel plate mentioned above usable for the present invention are different in the shapes and functions to be required, a steel of the components in the range described in the following Table 2 will be suitably used, and further, P and S are substantially the same as those in the above S25CTiB. Wt.% means weight %.

Table 2

C	Si	Mn
0.20 ~ 0.6% (wt%)	0.01 ~ 0.1%	0.05 ~ 0.5%
Ti	B	Elongation
0.01 ~ 0.1 %	0.001 ~ 0.01 %	≥30 %

[0061] The front cover 106 and the impeller shell 102 after being plastically formed are strengthened as compared with the conventional ones by effecting the induction hardening (including underwater induction hardening) to surfaces of materials containing C of 0.25 weight % with B added, such as the fitting portion with the inner rotor 21 of the oil pump 18, the rotational sliding portion with the bearing bush 22, the outer peripheral bent portion of the front cover 106 and the inside surface portion pressed by the lock-up piston 29, at which strength lowering or damage may be caused by the plate thickness reduction.

[0062] In such operation, the induction hardening is not a full-surface hardening, and it will be preferred that the hardening is performed so as to provide a pattern of radial lines as shown in Fig. 9A or pattern of rings as shown in Fig. 9B.

[0063] In the above embodiment, although the ring gear 110 for the starter is located on the side of the impeller shell 102, the ring gear 110 may be formed through the plastic working to the outer peripheral portion of the front cover 106 together with the flanged portion 107 as shown in Fig. 10.

[0064] While the presently preferred embodiment of the present invention has been shown and described, it is to be understood that this disclosure is for the purpose of illustration and that various changes and modifications may be made without departing from the scope of the invention as set forth in the appended claim.

Claims

1. A torque converter having, an impeller shell, a pump impeller integrally formed with said impeller shell, a turbine runner, a stator, a front cover, comprising:

   a flanged portion formed to an outer peripheral portion of an outer hull constituting member including the impeller shell and the front cover for transmitting a driving power of an engine, and a ring gear for starting said engine;
   a pilot boss portion disposed to an axial portion of the front cover and adapted to be fitted to a crank shaft of the engine; and
   an oil pump driving shaft in a sleeve shape disposed to an axial portion of the impeller shell and adapted to drive an oil pump; and
   said pilot boss portion is formed integrally with the front cover through a plastic working; and
   the flanged portion is formed to a front portion of the outer periphery of the front cover is increased in thickness through a plastic working as a laminated thickness increased portion.

2. The torque converter according to claim 1,
   wherein said ring gear for the starter is integrally formed to a rear portion of the outer periphery of the front cover through a plastic working.

3. The torque converter according to claim 1, wherein:

   said sleeve-shaped oil pump driving shaft is formed integrally with the impeller shell through the plastic working; and

   said ring gear for the starter is integrally formed so as to form an increased thickness portion through the plastic working.

4. The torque converter according to claim 1; further comprising:

   a water-tight brazing and a coating layer formed to at least a portion of an inner peripheral side boundary portion of the flanged portion which is short-circuited to a screw hole portion formed to the flanged portion.

5. The torque converter according to claim 1, wherein said flanged portion and said ring gear for the starter are integrally formed through the plastic working to the outer peripheral portion of the outer hull constituting member including the front cover and the impeller shell so that the integrally formed portions perform an inertia function and a power transmission function.

6. A torque converter having, an impeller shell, a pump impeller integrally formed with the impeller shell, a turbine runner, a stator, a front cover, comprising:

   a flanged portion formed to an outer peripheral portion of an outer hull constituting member including the impeller shell and the front cover, to which a said driving power of an engine is transmitted;

   a pilot boss portion disposed to an axial portion of the front cover and adapted to be fitted to a crank shaft of the engine; and

   an oil pump driving shaft in shape of sleeve disposed to an axial portion of the impeller shell and adapted to drive an oil pump; and

   said pilot boss portion is formed integrally with the front cover through a plastic working and the flanged portion

is formed to a front portion of the outer periphery of the front cover is increased in thickness through a plastic working as a laminated thickness increased portion.

7. The torque converter according to claim 6, further comprising:

   a water-tight brazing and coating layer is formed to at least a portion of an inner peripheral side boundary portion of the flanged portion; and

   said layer is short-circuited to a screw hole portion formed to the flanged portion.

8. The torque converter according to claim 6, wherein said sleeve-shaped oil pump driving shaft is formed integrally with the impeller shell through the plastic working.

9. The torque converter according to claim 6, wherein said flanged portion is integrally formed through the plastic working to the outer peripheral portion of the outer hull constituting member including the front cover and the impeller shell so that the integrally formed portions perform an inertia function and a power transmission function.

10. The torque converter having, an impeller shell, a pump impeller integrally formed with the impeller shell, a turbine runner, a stator, a front cover, comprising:

    a ring gear for a starter formed to an outer peripheral portion of an outer hull constituting member including the impeller shell and the front cover,

    a pilot boss portion disposed to an axial portion of the front cover and adapted to be fitted to a crank shaft of the engine, and

    an oil pump driving shaft in shape of sleeve disposed to an axial portion of the impeller shell and adapted to drive an oil pump, and

    said pilot boss portion is formed integrally with the front cover through a plastic working.

11. The torque converter according to claim 10, wherein said ring gear for the starter is integrally formed to a rear portion of the outer periphery of the front cover through a plastic working.

12. The torque converter according to claim 10, wherein said sleeve-shaped oil pump driving shaft is formed integrally with the impeller shell through the plastic working and said ring gear for the starter is integrally formed so as to form an increased thickness portion through the plastic working.

13. The torque converter according to claim 10, wherein said ring gear for the starter are integrally formed through the plastic working to the outer peripheral portion of the outer hull constituting member including the front cover and the impeller shell so that the integrally formed portions perform an inertia function and a power transmission function.

14. The torque converter according to any one of claims 1 to 13, wherein at least said front cover and impeller shell are formed, through a molding process, of a steel plate material consisting of, in weight %, C: 0.2-0.6, Si: 0.01-0.1, Mn: 0.05-0.5, Ti: 0.01-0.1, B: 0.001-0.01, and Fe: residue.

15. The torque converter according to claim 14, wherein an induction hardening is carried out to at least a portion, of the oil pump driving shaft, which is fined to the inner rotor of the oil pump and a bush fitting portion supported to a housing of an oil pump through the bush.

16. The torque converter according to claim 14, wherein an induction hardening is carried out to an inside surface of the oil pump driving shaft, which is opposed to a disc surface of the stator through a thrust bearing.

17. A torque converter according to claim 14, further comprising:

    an induction hardening is carried out to at least one of an inner surface of a disc portion of the front cover; and a surface thereof opposing to a turbine hub through a thrust bearing and a central protruded portion thereof.

FIG. 1

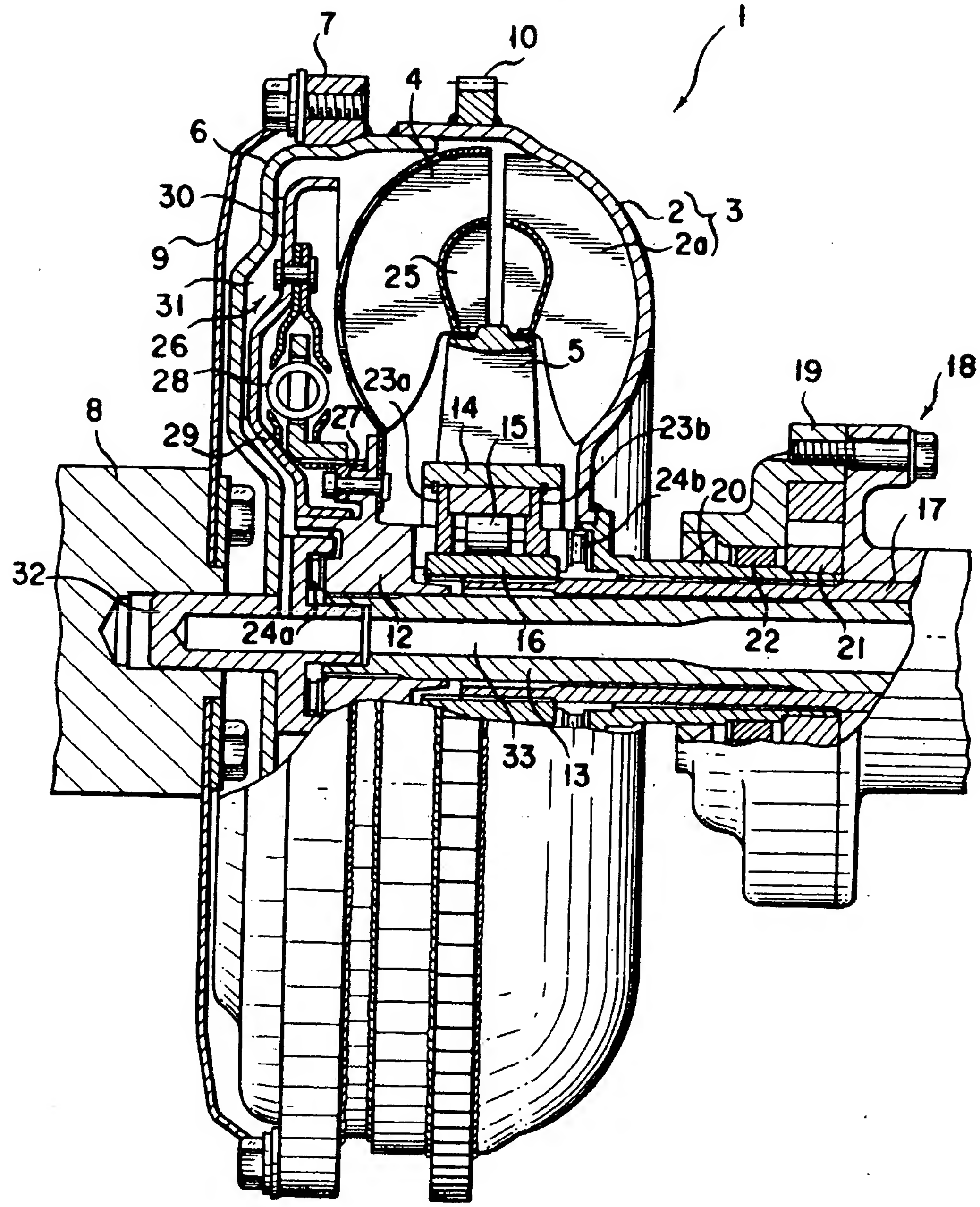

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FIG. 2

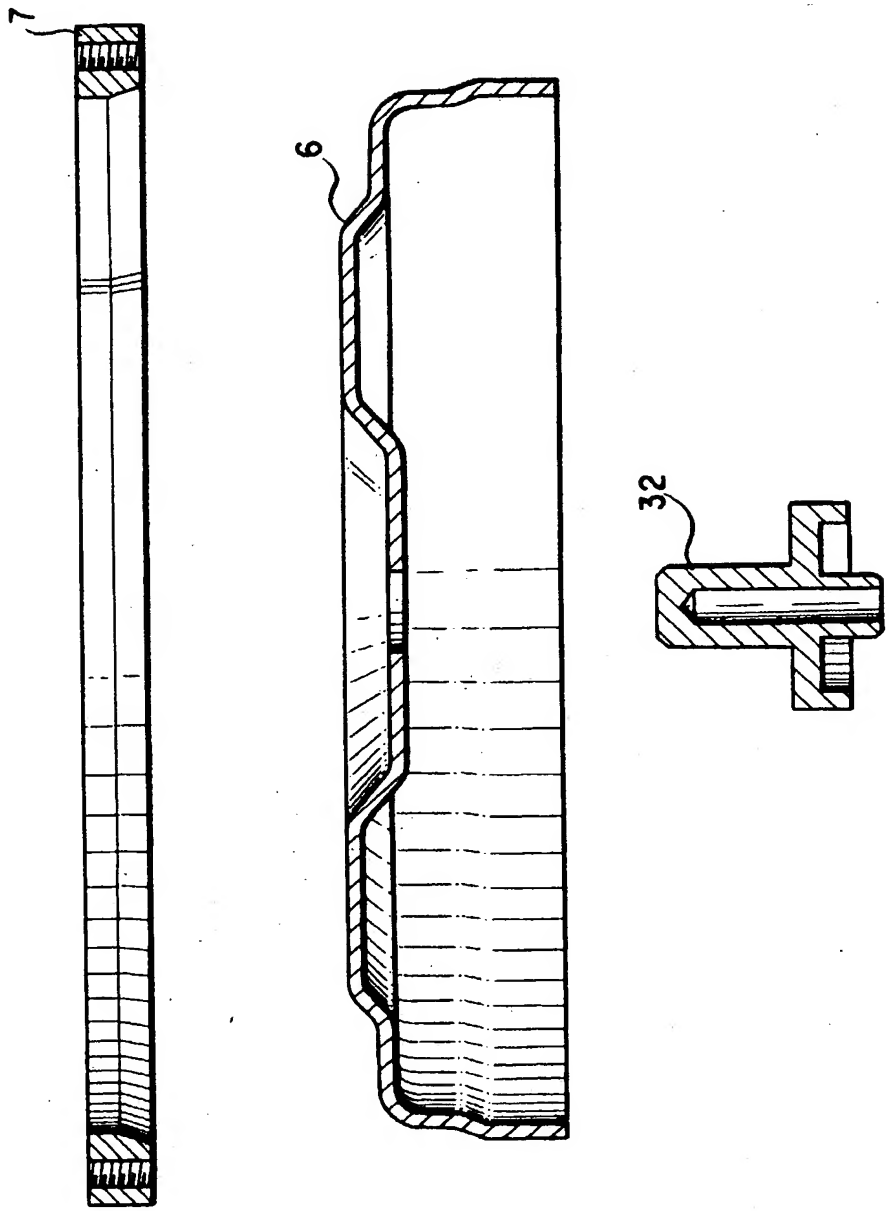


FIG. 3

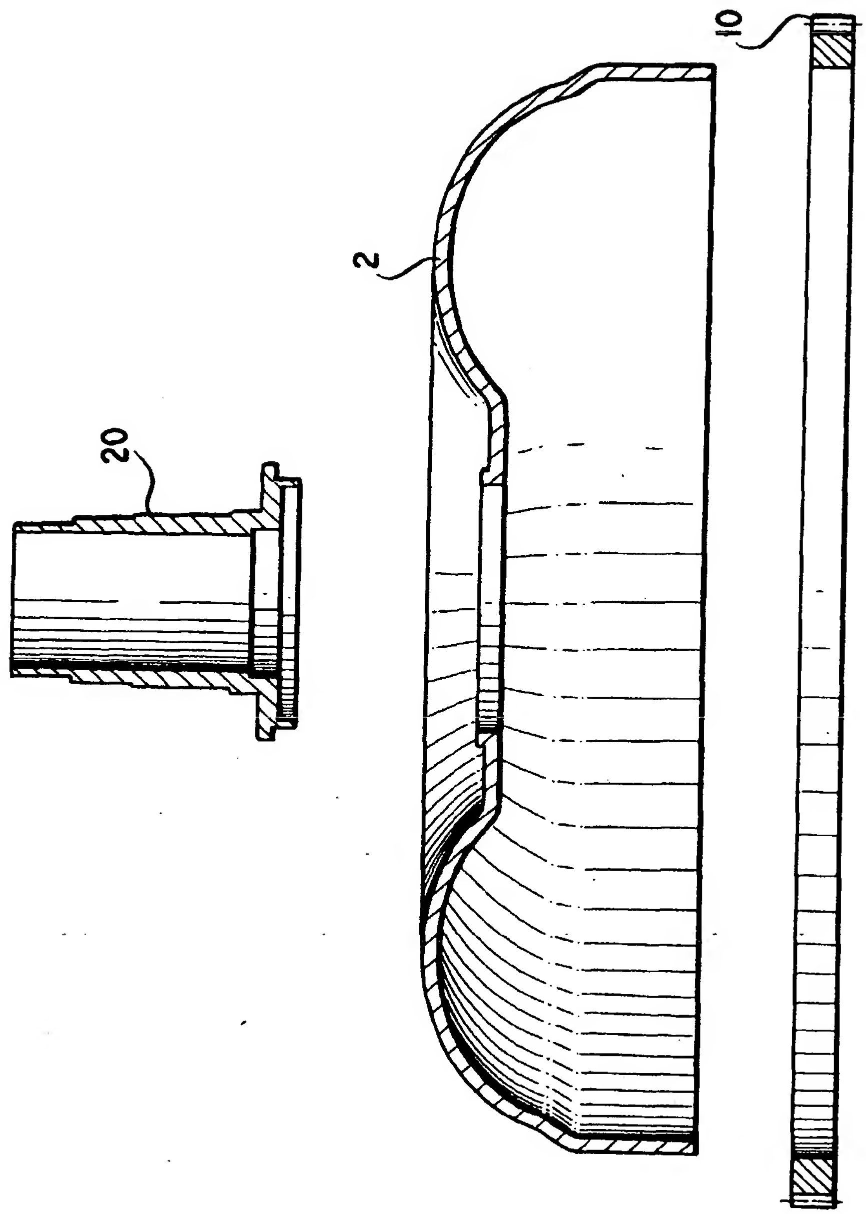


FIG. 4A

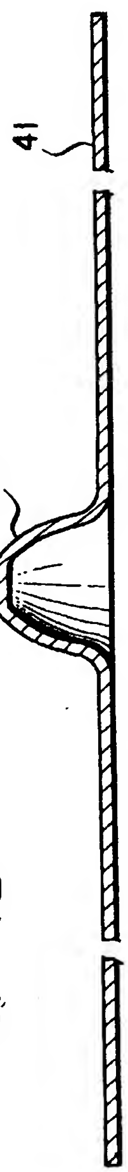


FIG. 4B

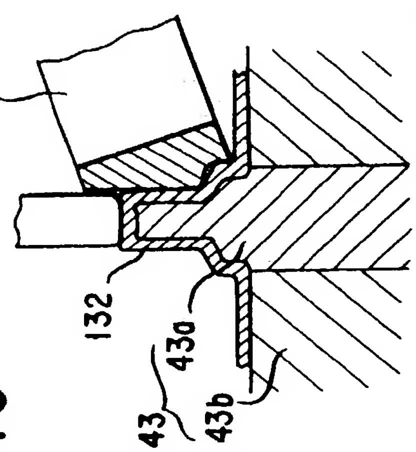


FIG. 4C

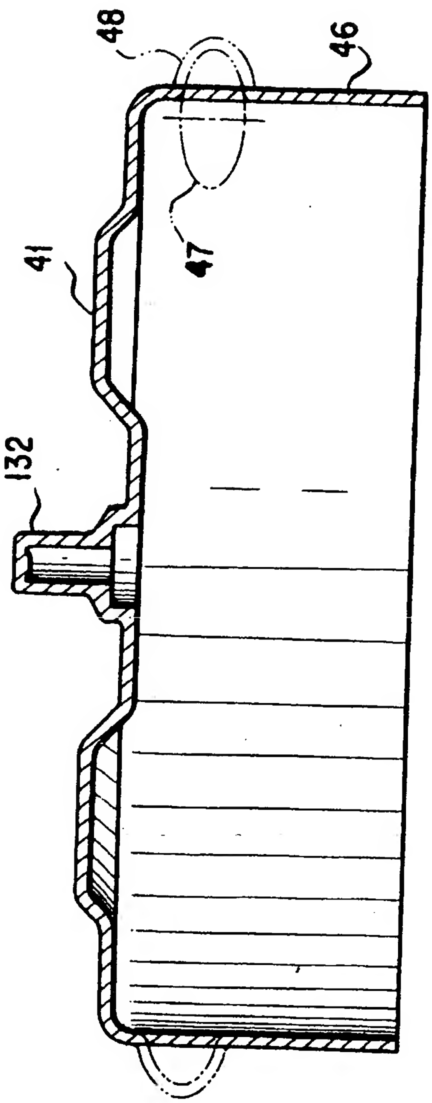


FIG. 4D

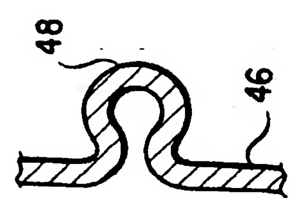


FIG. 4E

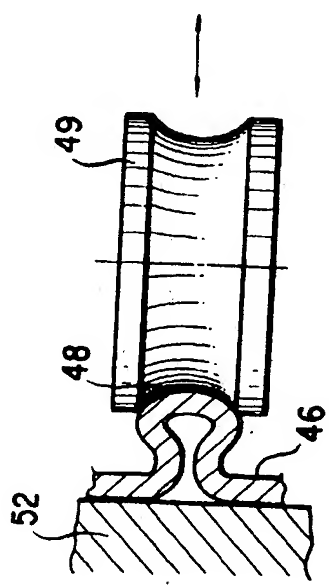


FIG. 4F

FIG. 4G

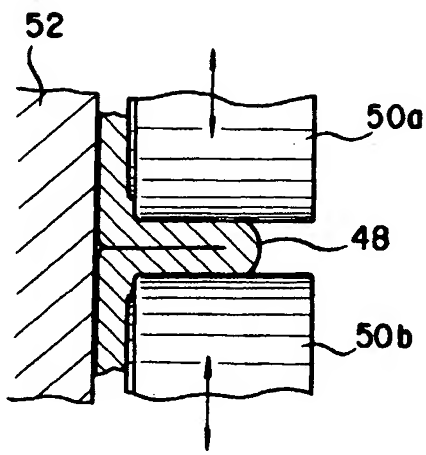


FIG. 4H

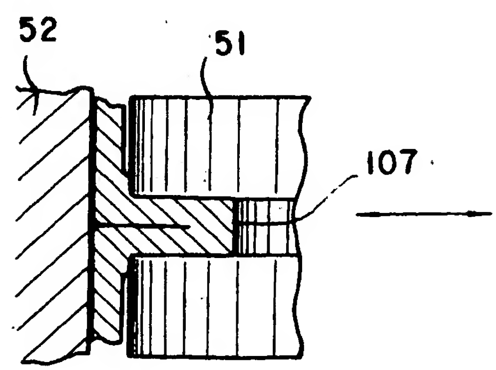


FIG. 5

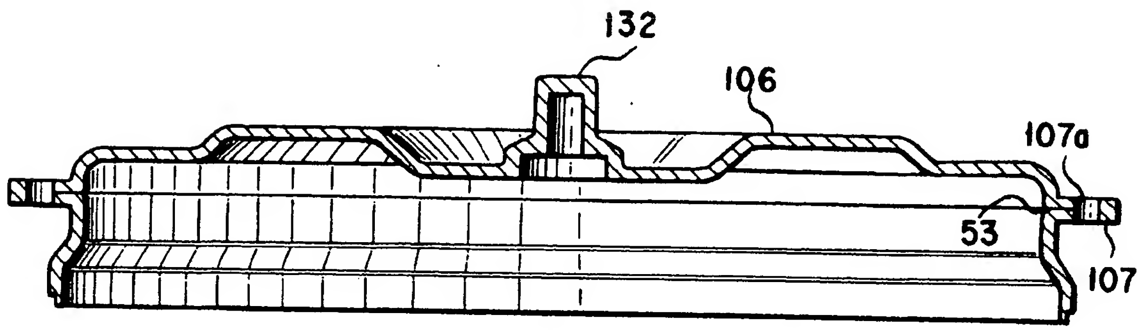


FIG. 6

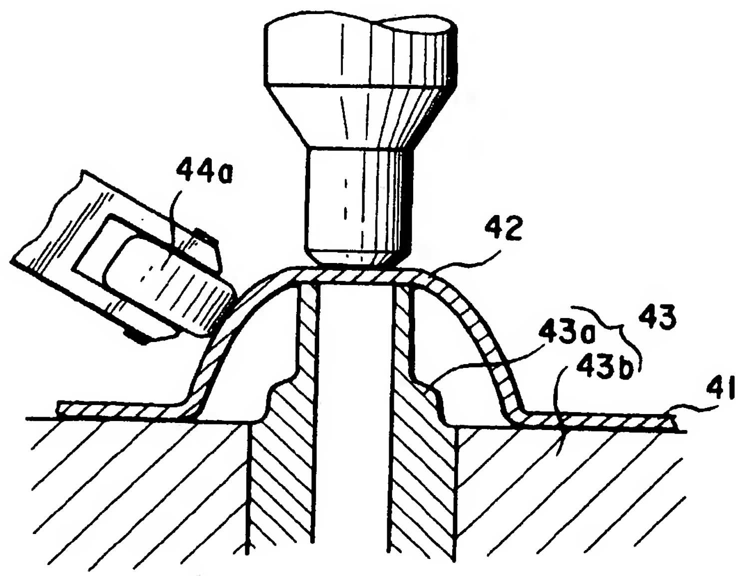


FIG. 7A

FIG. 7B

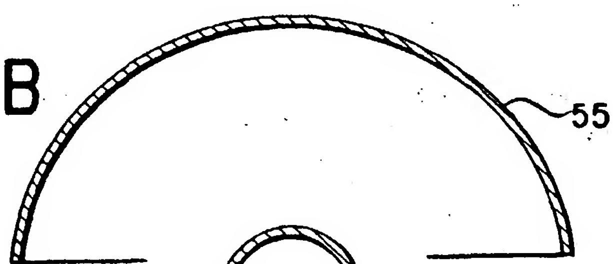


FIG. 7C

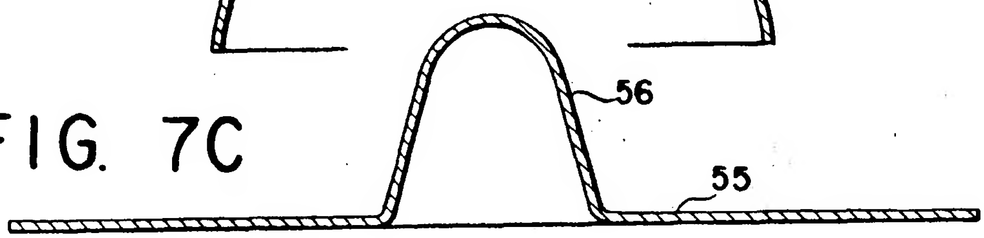


FIG. 7D

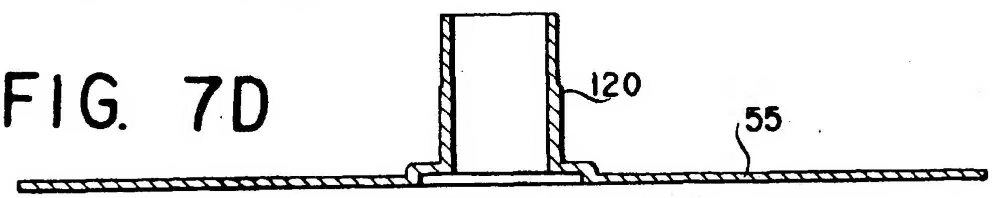


FIG. 7E

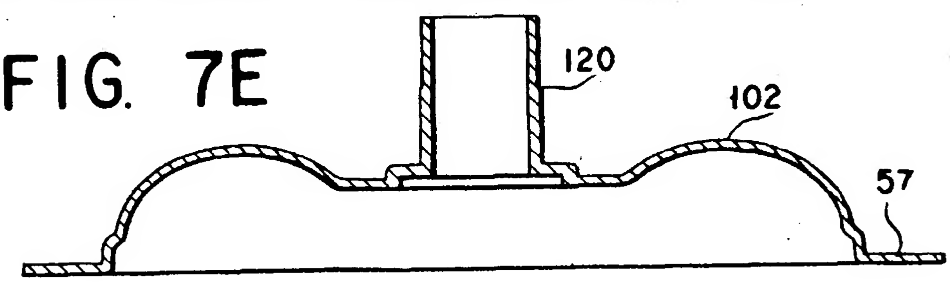


FIG. 7F

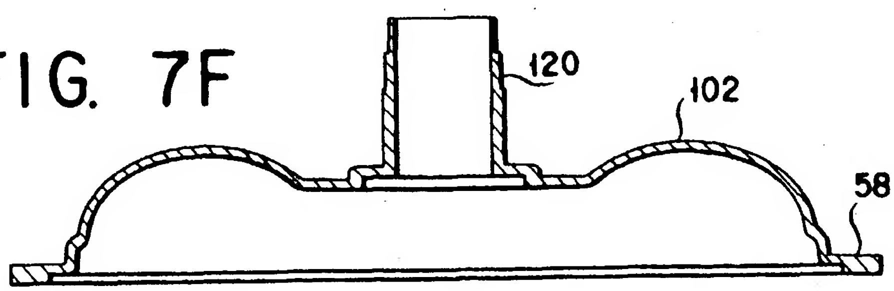


FIG. 8

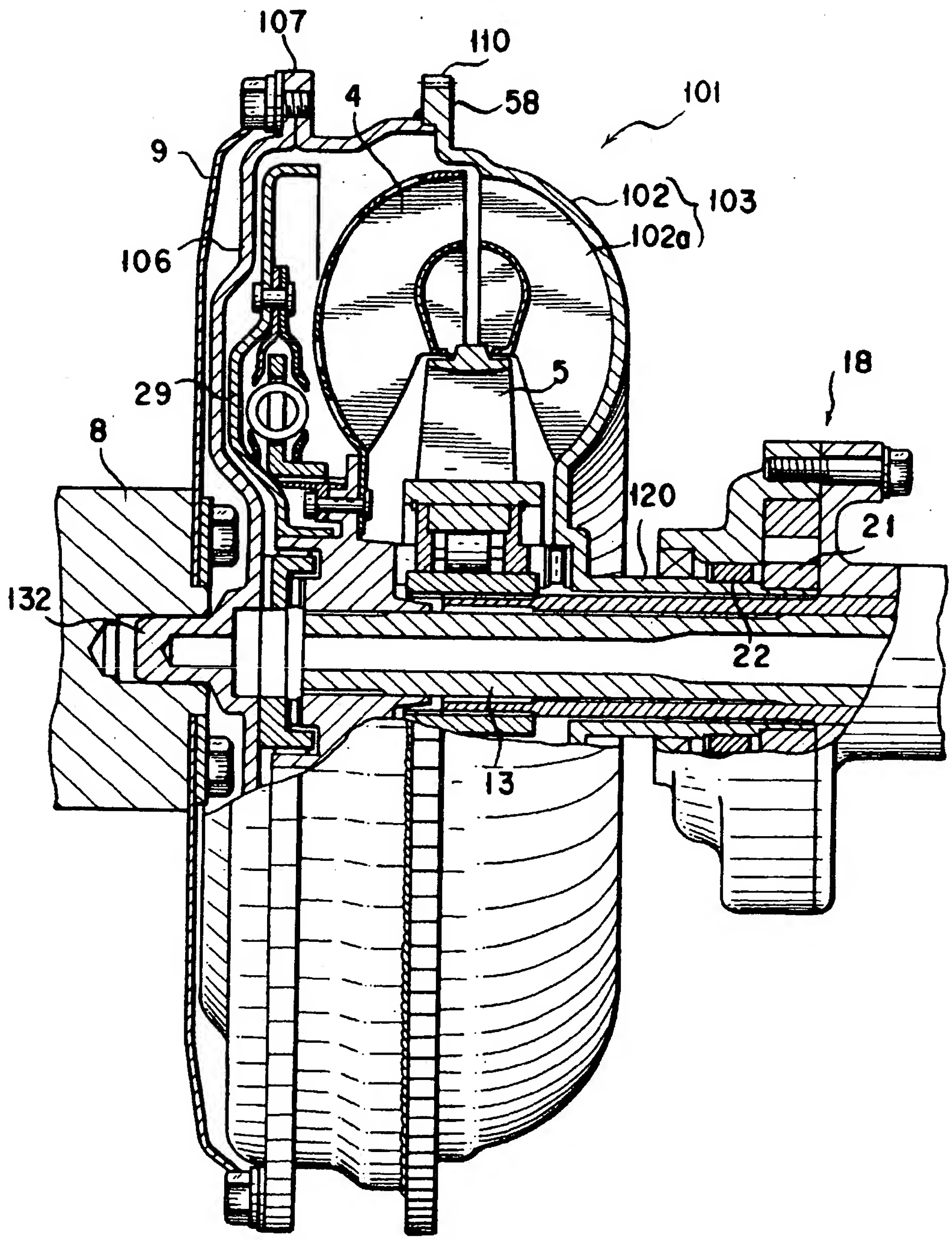


FIG. 9A

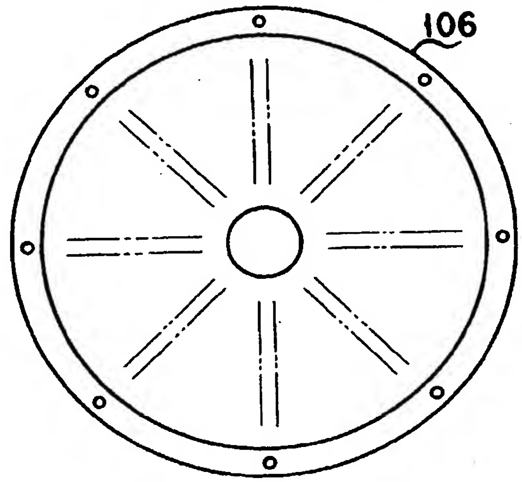


FIG. 9B

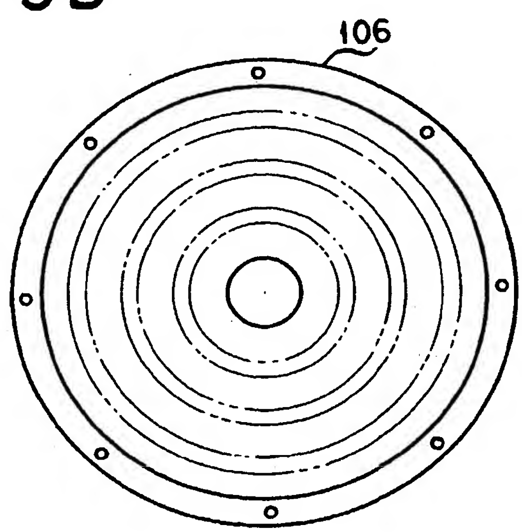
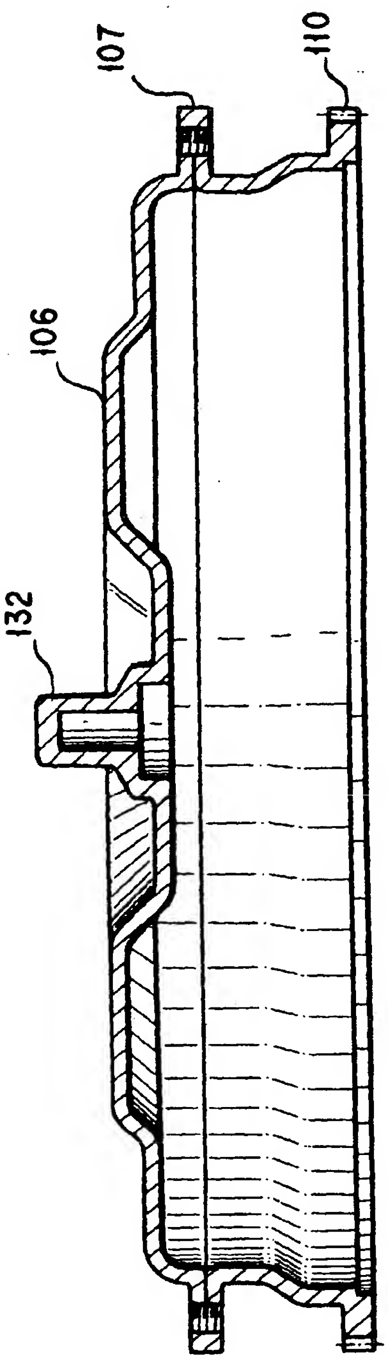


FIG. 10



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(71) Applicants:
- KUBOTA IRON WORKS CO., LTD.
Hiroshima-shi, Hiroshima-ken (JP)
- FUJI JUKOGYO KABUSHIKI KAISHA
Tokyo (JP)

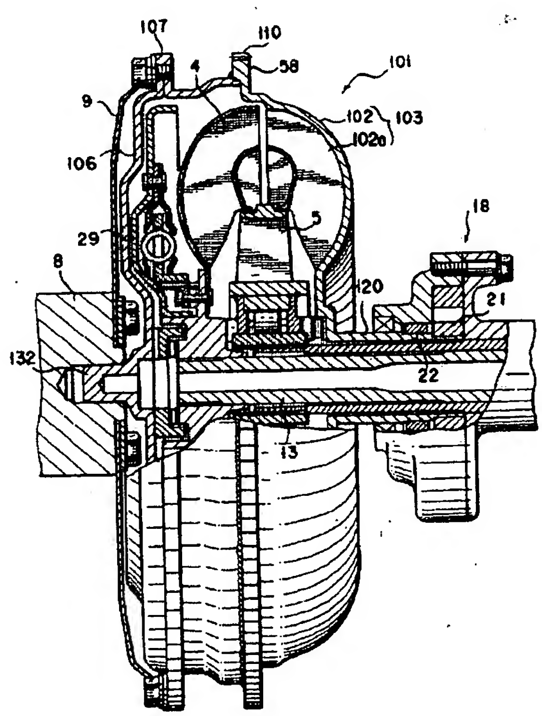
(72) Inventors:
- Yamanaka, Shigeaki
Aki-ku, Hiroshima-shi, Hiroshima (JP)
- Kobayashi, Toshio
Shinjuku-ku, Tokyo (JP)

(74) Representative: Schmitt, Armand et al
Office Ernest T. Freylinger S.A.,
B.P. 48
8001 Strassen (LU)

(54) Torque converter

(57) A torque converter comprises an impeller shell (2,102), a pump impeller (3,103) integrally formed with the impeller shell (2,102), a turbine runner (4),a stator (5), a front cover (6,106), and at least one of a flanged portion (7,107) through which a driving power of an engine is transmitted and a ring gear (10,110) for a starter. The flange portion (7,107) is formed to an outer peripheral portion of an outer hull constituting member including the impeller shell and the front cover. A pilot boss portion (32,132) disposed to an axial portion of the front cover and adapted to be fitted to a crank shaft of the engine, and an oil pump driving shaft (20,120) in shape of sleeve disposed to an axial portion of the impeller shell and adapted to drive an oil pump (21). The pilot boss portion (132) is formed integrally with the front cover through a plastic working and the flanged portion (107) is formed to a front portion of the outer periphery of the front cover is increased in thickness through a plastic working as a laminated thickness increased portion.

FIG. 8



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Application Number
EP 99 12 1403

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Y	DE 198 14 362 A (EXEDY CORP) 1 October 1998 (1998-10-01) * abstract * * column 1, line 21 - line 30 * * column 2, line 10 - line 28 * * figures 1-10 * ---	10	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	6 July 2001	Wilson, M

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